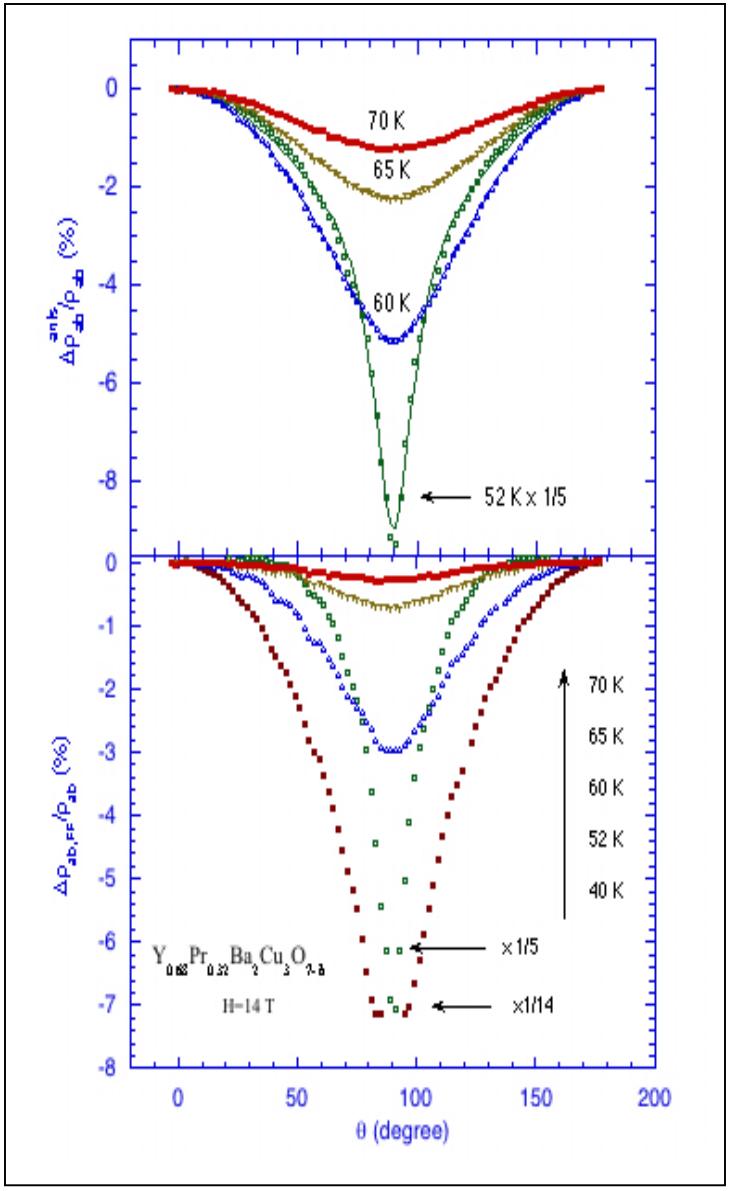
Electronic Properties of Layered Cuprates I

Carmen C. Almasan, Kent State University, DMR–0102415

Metal oxides constitute an amazing class of materials which exhibit a wide range of phenomena such as ferroelectricity, ferromagnetism, superconductivity and so on. The field of metal oxides became particularly important after the discovery of high-temperature superconductivity. It is generally accepted that the mechanism of superconductivity in cuprate superconductors is essentially connected with their highly anisotropic structure. However, it is not clear yet what is the origin of the superconducting gap and why, even in the normal state, these materials conduct electricity in ways that are very different from typical electrical conductors such as copper and silicon. We study the charge dissipation in the superconducting and normal states of these systems in order to shed more light into these issues.

The figures show the change of the magnetoresistivity with angle measured at different temperatures and in a magnetic field of 14 T. The top figure shown that, above the superconducting transition temperature T_{c0} = 55 K, the magnetoresistivity displays a deviation from the typical quasiparticle contribution (proportional to $\sin^2\theta$). The bottom figure gives the angular dependence of this non $\sin^2\theta$ contribution. We have shown that this contribution is a result of flux flow. This finding supports the scenario in which there are vortex-like excitations above the zero-field critical temperature, while T_{c0} is a result of long-range phase coherence.



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Educational:

– one undergraduate student;
– two graduate students, one just graduated and is now a post-doc at State University of New York at Stony Brook;
– one post-doc.

This research activity contributed to the development of experimental skills and experience with low-temperature systems, electronics, computer-controlled equipment, interfacing, and programming. The diversity of expertise gained by the undergraduate and graduate students, and post-doc in this research activity provides a substantial advantage in today's knowledge based, technology driven economy, being beneficial to a future career in industry, government, or academia.

Outreach activities:

Groups of students from local high schools visited the PI's laboratory and learned about physics in general, and superconductivity and magnetism in particular, through demonstrations and short lectures given by the PI and her graduate students. In this way, the high school students were exposed to a research environment and were given a flavor of the science done in the lab and the technology involved in doing it. In addition, the PI is involved in the Young Women's Summer Institute, which is a competitive program across Ohio for middle school girls, held on Kent State University Campus. During this program, the middle school girls are exposed to science experiments and also interact with female scientists at different stages in their carrier, i.e., undergraduate and graduate students, and faculty.

The two graduate students who work on this project transfer liquid helium in preparation for starting transport measurements on layered cuprate single crystals.